Reprinted from Neuro-Psychopharmacology

EEG AND BEHAVIORAL EFFECTS OF PSYCHOPHARMACOLOGIC AGENTS*

M. FINK

Department of Experimental Psychiatry, Hillside Hospital, Glen Oaks, Long Island, N.Y. (U.S.A.)

Recent studies have presented data supporting a neurophysiologic-adaptive view of the convulsive therapy process[4, 15]. This hypothesis holds that the clinical efficacy of repeated induced convulsions is dependent upon the induction of a persistent alteration in cerebral function, which provides the milieu for changes in the subject's interaction with the environment. In these studies the best index of neurophysiologic change has been those aspects of cerebral function reflected by δ activity in the electroencephalogram[8–10].

The efficacy of newer psychopharmaceuticals in altering psychotic behavior patterns led to the suggestion of a similar hypothesis for the mode of action of these agents[4], and to studies of the relationship and specificity of altered behavioral patterns to neurophysiologic change as reflected in electroencephalography. This report summarizes some of the experimental data observed in on-going tests of this hypothesis.

SUBJECTS AND METHODS

We have studied consecutive patients, suffering from depressive psychoses, agitated and excited schizophrenic states and severe psychoneurotic disorders, referred for physiodynamic therapies (convulsive, psychotropic drug, insulin coma) in a voluntary, open-ward, psychiatric hospital. Serial electroencephalograms were taken prior to,

* Aided, in part, by grants M-927 and MY-2092, National Institute of Mental Health, National Institutes of Health, U.S.P.H.S., and Bristol, Wyeth and Smith, Kline and French Laboratories.

References p. 446.

during and after the course of therapy. In addition, at various stages of the treatment program acute experimental studies were done. As both convulsive and chlorpromazine therapies elicit varying degrees of EEG slow wave activity, these acute observations have been made in two groups of subjects: those without slow wave activity, and those with diffuse slow wave (HSD, LSD) or burst and slow wave (BSD) activity[18].

Observations have been made in the EEG laboratory. Following a routine bipolar EEG recording, an unstructured psychiatric interview was tape-recorded. Under continuous EEG recording, medication was administered intravenously at a set rate until EEG or behavioral effects were observed. Following the injection the interview was repeated and recorded. Periods of EEG recording and interview recording were alternated for the duration of the drug activity.

Behavioral evaluations have been based both on clinical descriptions by the participants (subject, physician and technician) and analyses of changes in language patterns[12, 14]. Electroencephalograms were measured for shifts in dominant frequencies, and changes in voltage, modulation, and per cent time of α, β and δ frequency bands.

The psychopharmacologic agents were administered orally for extended periods in clinical trials, and intravenously in the acute experimental trials (Table I). Dosage for each compound varied, but in each instance sufficient medication has been given to achieve clinical behavioral effects.

TABLE I

PSYCHOPHARMACOLOGIC AGENTS STUDIED

(Oral and intravenous)

Chlorpromazine	Amobarbital	Atropine **
Promazine	Thiopental **	Diethazine **
Triflupromazine		LSD-25[b]
Perphenazine	Amphetamine	Win-2299[c] **
Reserpine *	Methamphetamine	JB-318[d] **
		JB-336[e] **
Iproniazid	Meprobamate *	
Deanol[a] **		Benactyzine

[a] Dimethylaminoethanol[17].
[b] Lysergic acid diethylamide.
[c] 2-Diethylaminoethyl cyclopentyl (2-thienyl) glycolate[16].
[d] N-Ethyl-3-piperidyl benzilate[1].
[e] N-Methyl-3-piperidyl benzilate[1].

* Oral only.
** Intravenous only.

OBSERVATIONS

(a) *Electroencephalographic*

Four broad types of EEG patterns may be identified according to the characteristics of frequency shift and synchronization[4]:

References p. 446.

1) Increase in slow wave activity and in synchrony;
2) Increase in synchrony without frequency shift;
3) Increase in fast wave activity and in synchrony;
4) Desynchronization and frequency irregularity.

Examples of each are seen in Figs. 1–4.

During convulsive therapy, an increase in slow wave activity and synchrony is manifest[8]. With drug administration similar changes in frequency spectrum and in synchrony can be observed. Such changes include an augmentation of the slow wave activity[8] or a marked decrease in such activity with desynchronization of frequencies[5].

Of the psychopharmaceuticals tested in acute experiments an increase in synchrony with or without an increase in slow wave activity has been observed for chlorpromazine, promazine, and trifluprom azine. Barbiturates regularly induce an increase in fast activity with an increase in synchrony, while amphetamine and

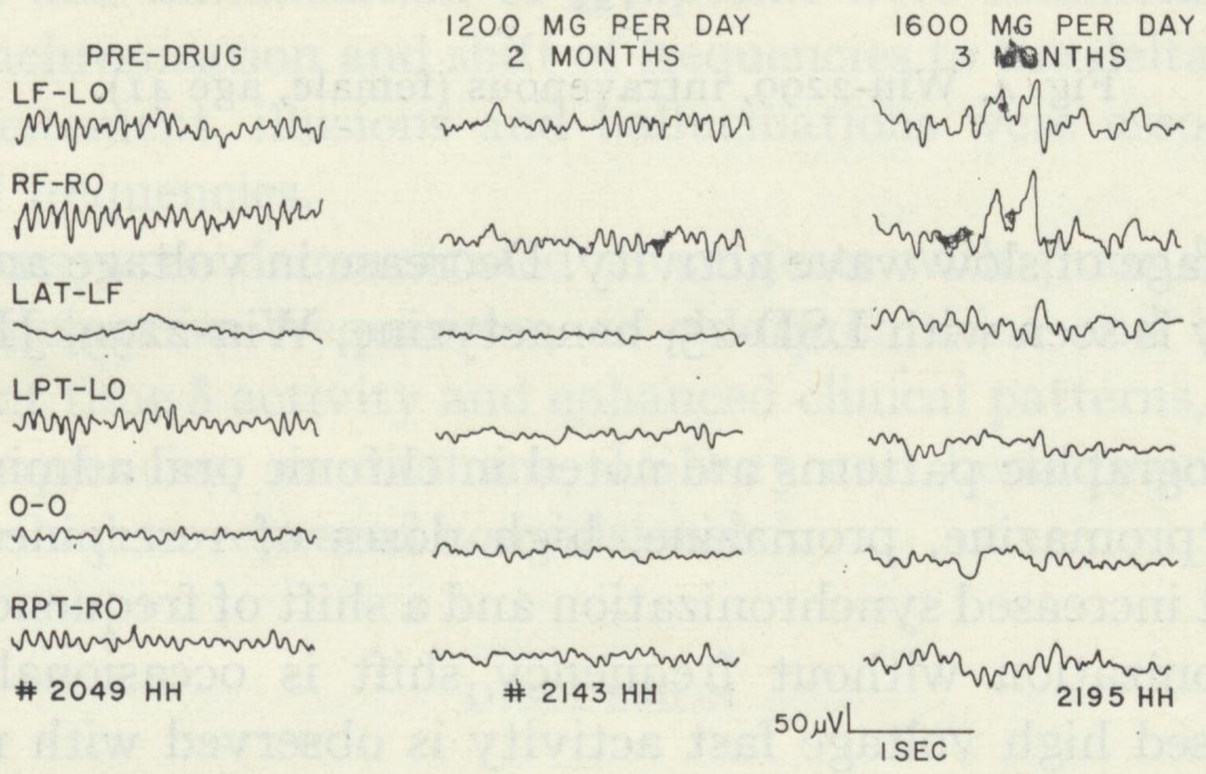

Fig. 1. Chlorpromazine, oral (male, age 15).

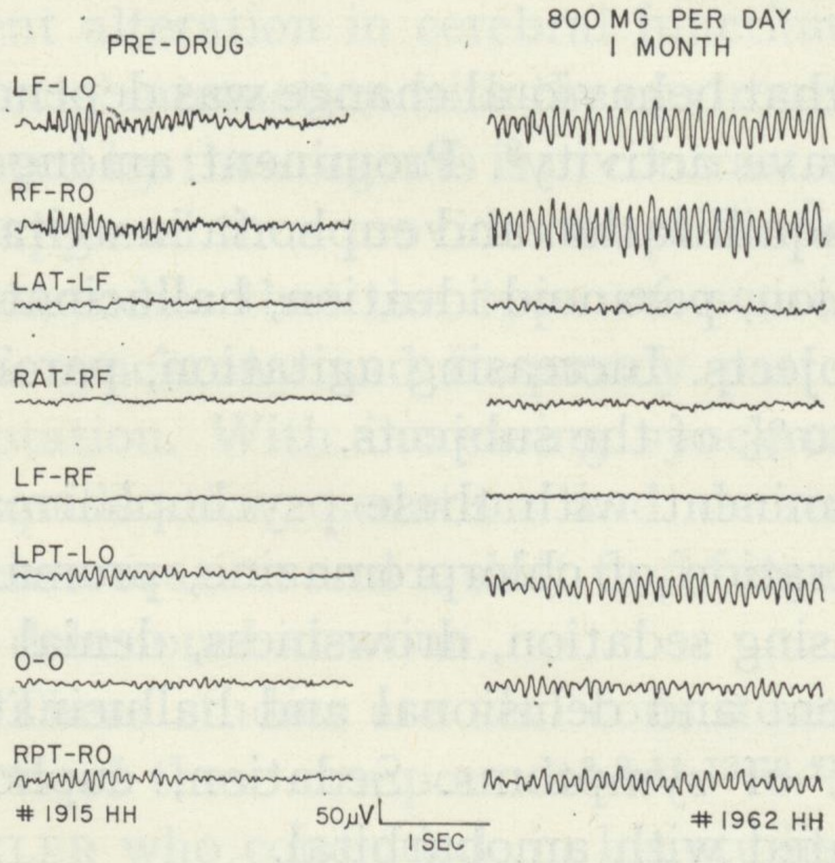

Fig. 2. Chlorpromazine, oral (female, age 34).

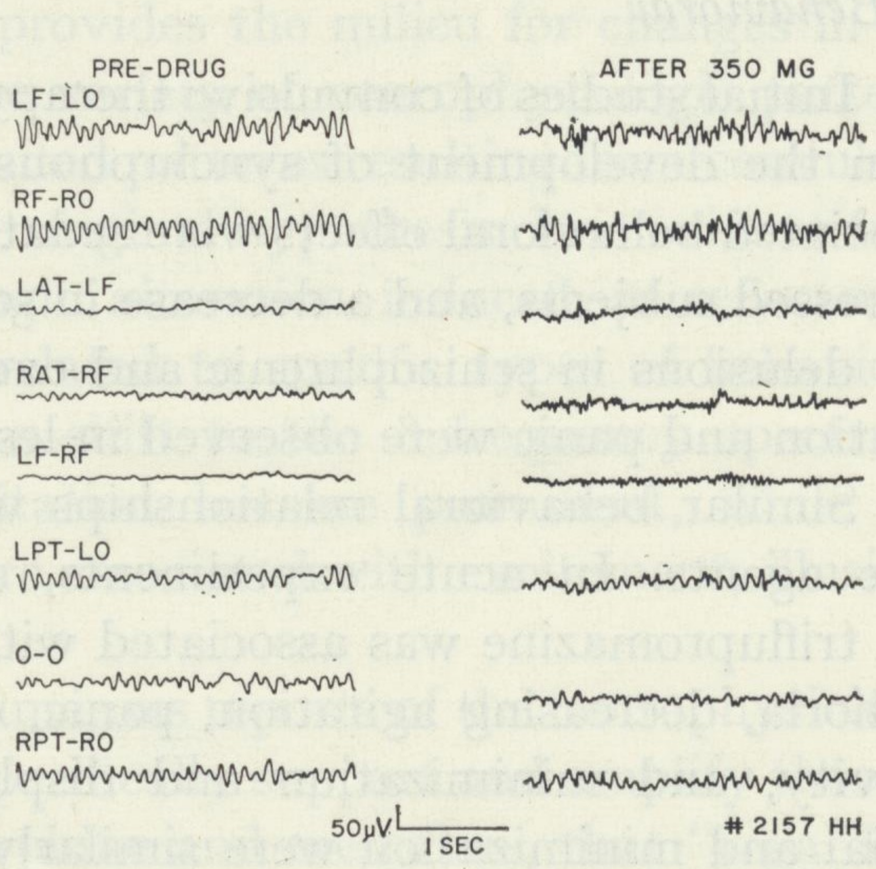

Fig. 3. Amobarbital, intravenous (male, age 31).

methamphetamine increase fast activity without increased synchrony. Desynchronization of frequencies is prominent after diethazine, LSD-25, Win-2299, JB-318, JB-336, and benactyzine.

References p. 446.

In subjects with post-convulsive δ activity, acute administration of chlorpromazine, promazine, triflupromazine, amobarbital and pentothal increased the per

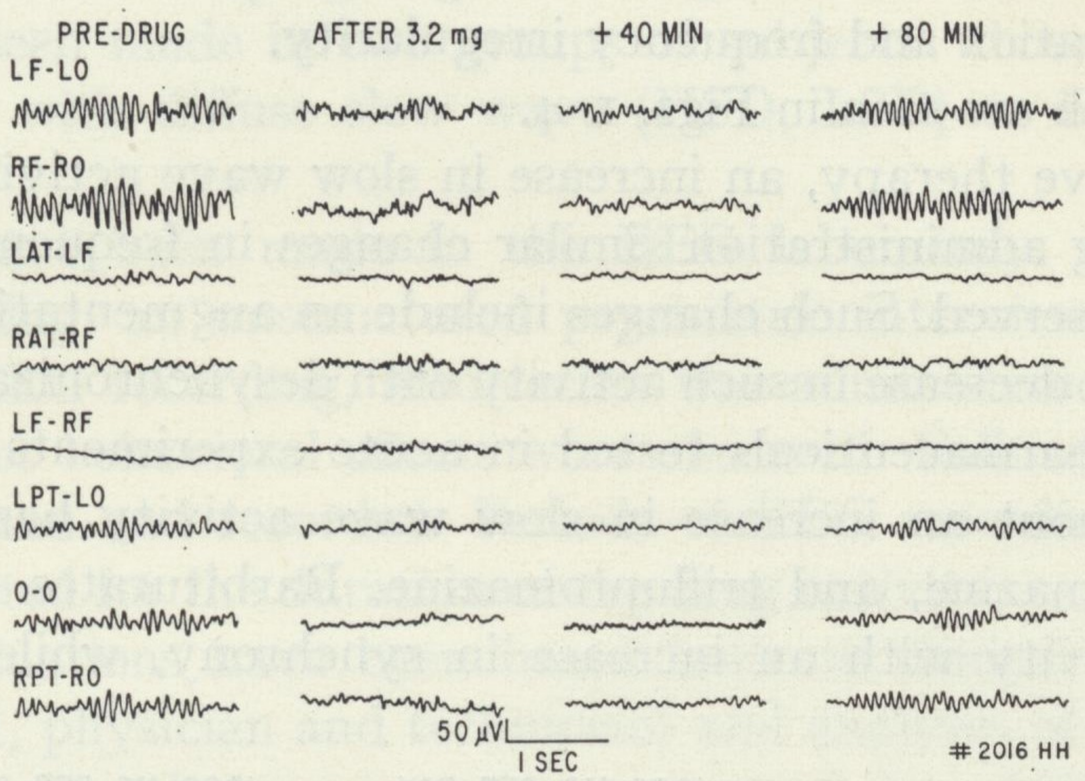

Fig. 4. Win-2299, intravenous (female, age 41).

cent time and voltage of slow wave activity. Decrease in voltage and per cent time of slow wave activity is seen with LSD-25, benactyzine, Win-2299, JB-318, JB-336 and diethazine[5, 6].

Similar electrographic patterns are noted in chronic oral administration of these compounds. Chlorpromazine, promazine, high doses of reserpine and occasionally perphenazine elicit increased synchronization and a shift of frequencies to the δ range. Increased synchronization without frequency shift is occasionally observed with iproniazid. Increased high voltage fast activity is observed with meprobamate and barbiturates. Oral administration of LSD-25 and benactyzine induces EEG desynchronization with an increase in fast frequencies.

(*b*) *Behavioral*

Initial studies of convulsive therapy noted that behavioral change was dependent upon the development of synchronous slow wave activity[8]. Prominent among the associated behavioral effects were sedation, tranquillization and euphoria in agitated, depressed subjects, and a decrease in somatization, paranoid ideation, hallucinations and delusions in schizophrenic and excited subjects. Increasing agitation, paranoid ideation and panic were observed in less than 10 % of the subjects.

Similar behavioral relationships were prominent with these psychopharmacologic agents. In acute experiments, administration of chlorpromazine, promazine and triflupromazine was associated with increasing sedation, drowsiness, denial and euphoria, decreasing agitation, panic, excitement and delusional and hallucinatory activity, and minimization and displacement of symptoms. Sedation, euphoria, denial and minimization were similarly associated with amobarbital.

Administration of amphetamine and methamphetamine resulted in behavioral alerting, hypomania, excitement, and increased motor activity. Similar increased alerting, excitement, tension and panic were observed after benactyzine. In addition to these patterns, illusory sensations and hallucinatory, delusional and paranoid ideation were observed with diethazine, LSD-25, Win-2299, JB-318, and JB-336.

References p. 446.

Equally prominent with the behavioral changes were alterations in patterns of language. Previous studies of convulsive therapy had indicated that specific syntactic language patterns (as in the use of the third person mode, past and future tense, displacement, minimization, denial, clichés, and cryptic remarks) increased with increasing neurophysiologic change[14]. These language patterns were further exaggerated by intravenous amobarbital[14, 15]. In the present studies, chlorpromazine, triflupromazine and iproniazid increased these language patterns. Diethazine, LSD-25, Win-2299, and benactyzine decreased and reversed these language patterns, increasing the use of the present tense, first person mode, and somatization[7].

(c) Relation of behavioral and electrographic observations

The electrographic patterns were consistently altered concurrently with behavioral changes both in the acute and chronic administration studies. Tranquillization, euphoria, sedation and minimization of symptoms were commonly associated with increased EEG synchronization and shift of frequencies to the delta range. Agitation, tension, panic, excitement, illusions and hallucinations were associated with a desynchronization of frequencies.

Similar patterns were demonstrated in subjects with prior δ activity. Agents that tended to synchronize frequencies, as chlorpromazine and barbiturates, augmented the per cent time δ activity and enhanced clinical patterns, while agents that desynchronized frequencies, as diethane, LSD-25 and benactyzine, minimized the clinical effects ascribed to repeated convulsions[5–7].

DISCUSSION

These observations are consistent with the neurophysiologic-adaptive hypothesis of the mode of action of the newer psychopharmaceuticals[4]. This hypothesis states that the clinical efficacy of psychotropic drugs is dependent upon the induction of a persistent alteration in cerebral function which provides the milieu for changes in the subjects' interaction with the environment. The variety of neurophysiologic patterns induced by these agents is in contrast to the limited patterns resulting from convulsive therapy and thus provides amplification of the original hypothesis. It is evident from these studies that the type of neurophysiologic alteration induced, as reflected in EEG synchrony and frequency patterns, is related to specific types of behavioral adaptation. With increasing synchrony and a shift to the δ frequency spectrum, tranquillization, sedation and decreased agitation become prominent, while desynchronization and a shift to β frequencies are associated with excitement, illusions and delusional ideation.

These studies are also consistent with numerous reports of the neurophysiologic effects of these compounds[2,3,11,13,19,21], and specifically support and amplify those of WIKLER who concluded, in his studies of morphine and mescaline, that "regardless of the nature of the drug administered, shifts in the pattern of the electroencephalogram in the direction of desynchronization occurred in association with anxiety, hallucinations, fantasies, illusions or tremors, and in the direction of synchronization with euphoria, relaxation or drowsiness"[20].

This hypothesis, and the electrographic measure of neurophysiologic change, lends itself to application in the assay of new psychotropic drugs[4], the rational

References p. 446.

application of pharmacotherapy[7], and as a basis for further experimental study of neurophysiologic–behavioral relationships in psychiatry.

ACKNOWLEDGEMENT

We are grateful for the cooperation of the following laboratories who made supplies of the various psychopharmaceuticals freely available: Ciba Pharmaceutical Prods. (reserpine), Lakeside Laboratories (JB-318, 336), Eli Lilly & Co. (amobarbital), Merck, Sharpe & Dohme (benactyzine), Riker Laboratories (deanol), Roche Laboratories (iproniazid), Sandoz Pharmaceuticals (LSD-25), Schering Corp. (perphenazine), Smith, Kline & French Laboratories (chlorpromazine, diethazine), E. R. Squibb & Sons (triflupromazine), Winthrop Laboratories (Win-2299), Wyeth Laboratories (promazine, meprobamate).

REFERENCES

1 L. G. ABOOD, A. M. OSTFELD AND J. BIEL, *Proc. Soc. Exptl. Biol. Med.*, 97 (1958) 483.
2 K. ANDERMANN, *Med. J. Australia*, 2 (1957) 1.
3 P. B. BRADLEY AND J. ELKES, *Brain*, 80 (1957) 77.
4 M. FINK, *J. Hillside Hosp.*, 6 (1957) 197.
5 M. FINK, *A.M.A. Arch. Neurol. Psychiat.*, 80 (1958) 380.
6 M. FINK, *Electroencephalog. and Clin. Neurophysiol.*, 10 (1958) 776.
7 M. FINK, J. JAFFE AND R. L. KAHN, Drug-induced changes in interview patterns: linguistic and neurophysiologic indices, in J. SARWER-FONER, *The Dynamics of Psychiatric Drug Therapy*, C. C. THOMAS, Springfield, Ill.
8 M. FINK AND R. L. KAHN, *A.M.A. Arch. Neurol. Psychiat.*, 78 (1957) 516.
9 M. FINK, R. L. KAHN AND M. A. GREEN, *Diseases of Nervous System*, 19 (1958) 113.
10 M. FINK, R. L. KAHN AND H. KORIN, *Proc. Intern. Congr. Neurol. Sci.*, 1957, Brussels, in the press.
11 S. GARATTINI AND V. GHETTI, *Psychotropic Drugs*, Elsevier, Amsterdam, 1957.
12 J. JAFFE, *J. Hillside Hosp.*, 6 (1957) 207.
13 R. S. JORGENSEN AND M. H. WULFF, *Electroencephalog. and Clin. Neurophysiol.*, 10 (1958) 325.
14 R. L. KAHN AND M. FINK, in P. HOCH AND J. ZUBIN, *Psychopathology of Communication*, Grune & Stratton, New York, 1958, p. 126.
15 R. L. KAHN, M. FINK AND E. A. WEINSTEIN, *A.M.A. Arch. Neurol. Psychiat.*, 76 (1956) 23.
16 H. PENNES AND P. HOCH, *Am. J. Psychiat.*, 113 (1957) 887.
17 C. C. PFEIFFER *et al.*, *Science*, 126 (1957) 610.
18 H. STRAUSS, M. OSTOW AND L. GREENSTEIN, *Diagnostic Electroencephalography*, Grune & Stratton, New York, 1952.
19 G. VERDEAUX AND R. MARTY, *Rev. neurol.*, 91 (1954) 405.
20 A. WIKLER, *J. Nervous Mental Disease*, 120 (1954) 157.
21 D. L. WINFIELD AND G. H. AIVAZIAN, *Electroencephalog. and Clin. Neurophysiol.*, 10 (1958) 575.

Printed in The Netherlands

EEG and Behavioral Effects of Psychopharmacologic Agents

Max Fink M.D.

From the Department of Experimental Psychiatry, Hillside Hospital, Glen Oaks, L.I., N.Y.

Aided, in part, by grants M-927 and MY-2092, National Institute of Mental Health, National Institutes of Health, U.S.P.H.S., and Bristol, Smith, Kline and French and Wyeth Laboratories.

Read at the Collegium Internationale Neuro-Psychopharmacologicum, Rome, September 12, 1958.

IV:9-3-58

EEG and Behavioral Effects of Psychopharmacologic Agents

Recent studies have presented data supporting a neurophysiologic-adaptive view of the convulsive therapy process (1, 2). This hypothesis holds that the clinical efficacy of repeated induced convulsions is dependent upon the induction of a persistent alteration in cerebral function, which provides the milieu for changes in the subject's interaction with the environment. In these studies the best index of neurophysiologic change has been those aspects of cerebral function reflected by delta activity in the electroencephalogram (3,4,5).

The efficacy of newer psychopharmaceuticals in altering psychotic behavior patterns led to the suggestion of a similar hypothesis for the mode of action of these agents (2), and to studies of the relationship and specificity of altered behavioral patterns to neurophysiologic change as reflected in electroencephalography. This report summarizes some of the experimental data observed in on-going tests of this hypothesis.

SUBJECTS AND METHODS:

We have studied consecutive patients, suffering from depressive psychoses, agitated and excited schizophrenic states and severe psycho-neurotic disorders, referred for physiodynamic therapies (convulsive, psychotropic drug, insulin coma) in a voluntary, open-ward, psychiatric hospital. Serial electroencephalograms were taken prior to, during and after the course of therapy. In addition, at various stages of the treatment program acute experimental studies were done. As both convulsive and chlorpromazine therapies elicit varying degrees of EEG slow wave activity,

these acute observations have been made in two groups of subjects: those without slow wave activity, and those with diffuse slow wave (HSD, LSD) or burst and slow wave (BSD) activity (6).

Observations have been made in the EEG laboratory. Following a routine bipolar EEG recording, an unstructured psychiatric interview was tape-recorded. Under continuous EEG recording, medication was administered intravenously at a set rate until EEG or behavioral effects were observed. Following the injection the interview was repeated and recorded. Periods of EEG recording and interview recording were alternated for the duration of drug activity.

Behavioral evaluations have been based both on clinical descriptions by the participants (subject, physician and technician) and analyses of changes in language patterns (7,8). Electroencephalograms were measured for shifts in dominant frequencies, and changes in voltage, modulation, and per cent time of alpha, beta and delta frequency bands.

The psychopharmacologic agents were administered orally for extended periods in clinical trials, and intravenously in the acute experimental trials (Table I). Dosage for each compound varied, but in each instance sufficient medication has been given to achieve clinical behavioral effects.

TABLE I

PSYCHOPHARMACOLOGIC AGENTS STUDIED

(Oral and Intravenous)

chlorpromazine	amobarbital	atropine **
promazine	thiopental **	diethazine **
trifluprom azine		LSD-25 (b)
perphenazine	amphetamine	Win-2299 (c) **
reserpine*	methamphetamine	JB-318 (d) **
		JB-336 (e) **
iproniazid	meprobamate *	
deanol (a) **		benactyzine

a. dimethylaminoethanol (9)

b. lysergic acid diethylamide

c. 2-diethylaminoethyl cyclopentyl (2-thienyl) glycolate (10)

d. n-ethyl-3-piperidylbenzilate (11)

e. n-methyl-3-piperidylbenzilate (11)

* oral only

** intravenous only

OBSERVATIONS:

(a) Electroencephalographic:

Four broad types of EEG patterns, observed on acute drug administration, may be identifie d according to the characteristics of frequency shift and synchronization (2):

1) Increase in slow wave activity and in synchrony;

2) Increase in synchrony without frequency shift;

3) Increase in fast wave activity and in synchrony;

4) Desynchronization and frequency irregularity.

Examples of each are seen in figures 1-4.

Fig. 1, 2, 3, 4

During convulsive therapy, an increase in slow wave activity and synchrony is manifest. (Fig.5) With drug administration similar changes

---

Fig. 5

---

in frequency spectrum and in synchrony are observed (Figs. 6, 7).

Figs. 6 7

Of the psychopharmaceuticals tested in acute experiments an increase in synchrony with or without an increase in slow wave activity has been observed for chlorpromazine, promazine and triflupromazine. Barbiturates regularly induced an increase in fast activity with an increase in synchrony, while amphetamine and methamphetamine increased fast activity without increased synchrony. Desynchronization of frequencies was prominent after diethazine, LSD-25, Win-2299, JB-318, JB-336 and benactyzine.

In subjects with post-convulsive delta activity, acute administration of chlorpromazine, promazine, trifluprom azine, amobarbital and pentothal increased the per cent time and voltage of slow wave activity. Decrease in voltage and per cent time of slow wave activity was seen with LSD-25, benactyzine, Win-2299, JB-318, JB-336, and diethazine (12-13).

Similar electrographic patterns were noted in chronic oral administration of these compounds. Chlorpromazine, promazine, high doses of reserpine and occasionally perphenazine elicited increased synchronization and a shift of frequencies to the delta range. Increased

synchronization without frequency shift was occasionally observed with iproniazid. Increased high voltage fast activity was observed with meprobamate and barbiturates. Oral administration of LSD-25 and benactyzine induced EEG desynchronization with an increase in fast frequencies.

(b) Behavioral:

Initial studies of convulsive therapy noted that behavioral change was dependent upon the development of synchronous slow wave activity (3). Prominent among the associated behavioral effects were sedation, tranquillization and euphoria in agitated, depressed subjects, and a decrease in somatization, paranoid ideation, hallucinations and delusions in schizophrenic and excited subjects. Increasing agitation, paranoid ideation and panic were observed in less than 10% of the subjects.

Similar behavioral relationships were prominent with these psychopharmacologic agents. In acute experiments, administration of chlorpromazine, promazine and trifluprom azine was associated with increasing sedation, drowsiness, denial and euphoria, decreasing agitation, panic, excitement and delusional and hallucinatory activity, and minimization and displacement of symptoms. Sedation, euphoria, denial and minimization were similarly associated with amobarbital.

Administration of amphetamine and methamphetamine resulted in behavioral alerting, hypomania, excitement, and increased motor activity. Similar increased alerting, excitement, tension and panic were observed after benactyzine. In addition to these patterns, illusory sensations and hallucinatory, delusional and paranoid ideation were observed with diethazine, LSD-25, Win-2299, JB-318 and JB-336.

Equally prominent with the behavioral changes were alterations in patterns of language. Previous studies of convulsive therapy had indicated that specific syntactic language patterns (as in the use of the third person mode, past and future tense, displacement, minimization, denial, cliches, and cryptic remarks) increased with increasing neurophysiologic change (7). These language patterns were further exaggerated by intravenous amobarbital (1, 7). In the present studies, chlorpromazine, trifluprom azine and iproniazid increased these language patterns. Diethazine, LSD-25, Win-2299, and benactyzine decreased and reversed these language patterns, increasing the use of the present tense, first person mode, and somatization (14).

(c) Relation of Behavioral and Electrographic Observations:

The electrographic patterns were consistently altered concurrently with behavioral changes both in the acute and chronic administration studies. Tranquillization, euphoria, sedation and minimization of symptoms were commonly associated with increased EEG synchronization and shift of frequencies to the delta range. Agitation, tension, panic, excitement, illusions and hallucinations were associated with a desynchronization of frequencies.

Similar patterns were demonstrated in subjects with prior delta activity. Agents that tended to synchronize frequencies, as chlorpromazine and barbiturates, augmented the per cent time delta activity and enhanced clinical patterns, while agents that desynchronized frequencies, as diethazine, LSD-25 and benactyzine, minimized the clinical effects ascribed to repeated convulsions (12, 13, 14).

DISCUSSION:

These observations are consistent with the neurophysiologic-adaptive hypothesis of the mode of action of the newer psychopharmaceuticals (2). This hypothesis states that the clinical efficacy of psychotropic drugs is dependent upon the induction of a persistent alteration in cerebral function which provides the milieu for changes in the subjects' interaction with the environment. The variety of neurophysiologic patterns induced by these agents is in contrast to the limited patterns resulting from convulsive therapy and thus provide amplification of the original hypothesis. It is evident from these studies that the type of neurophysiologic alteration induced, as reflected in EEG synchrony and frequency patterns, is related to specific types of behavioral adaptation. With increasing synchrony and a shift to the delta frequency spectrum, tranquillization, sedation and decreased agitation become prominent, while desynchronization and a shift to beta frequencies are associated with excitement, illusions and delusional ideation.

These studies are also consistent with numerous reports of the neurophysiologic effects of these compounds (15-20), and specifically support and amplify those of Wikler who concluded, in his studies of morphine and mescaline, that "regardless of the nature of the drug administered, shifts in the pattern of the electroencephalogram in the direction of desynchronization occurred in association with anxiety, hallucinations, fantasies, illusions or tremors, and in the direction of synchronization with euphoria, relaxation or drowsiness" (21).

This hypothesis, and the electrographic measure of neurophysiologic change, lends itself to application in the assay of new psychotropic drugs (2), the rational application of pharmacotherapy (14), and as a basis for further experimental study of neurophysiologic-behavioral relationships in psychiatry.

SUMMARY AND CONCLUSIONS:

The relation between electroencephalographic change and behavioral response was determined on acute and chronic administration of a variety of psychopharmacologic agents in voluntary, open-ward, psychiatric patients.

EEG patterns were classed according to effects on synchrony and frequency patterns. Behavioral and language pattern changes were noted as concurrent with EEG response.

Agents that induced an alteration in neurophysiology manifest as increased synchrony and frequency slowing in EEG were associated with behavioral sedation, tranquillity, and minimization of symptoms. Increased synchrony and increased frequency were associated with sedation, euphoria, hypomania and decreased somatization.

Desynchronization of frequencies was accompanied by increasing agitation, excitement, somatization, illusory phenomena and hallucinatory and delusional ideation.

The neurophysiologic-adaptive hypothesis of the mode of action of psychotropic drugs is supported; and the value of electroencephalography in the behavioral assay of these agents is suggested.

REFERENCES

1. Kahn, R.L., Fink, M. and Weinstein, E.A.: Relation of Amobarbital Test to Clinical Improvement in Electroshock, A.M.A. Arch. Neurol. & Psychiat. 76: 23-29, 1956.

2. Fink, M.: A Unified Theory of the Action of Physiodynamic Therapies, J. Hillside Hosp. 6: 197-206, 1957.

3. Fink, M. and Kahn, R.L.: Relation of EEG Delta Activity to Behavioral Response in Electroshock: Quantitative Serial Studies, A.M.A. Arch. Neurol. & Psychiat. 78: 516-525, 1957.

4. Fink, M., Kahn, R.L. and Green, M.A.: Experimental Studies of the Electroshock Process, Dis. Nerv. Sys. 19: 113-118, 1958.

5. Fink, M., Kahn, R.L. and Korin, H.: Relation of Tests of Altered Brain Function to Behavioral Change Following Induced Convulsions, Proc. Int. Cong. Neurol. Sci., 1957, Brussels, (in press).

6. Strauss, H., Ostow, M. and Greenstein, L.: Diagnostic Electroencephalography, Grune & Stratton, N.Y., 1952.

7. Kahn, R.L. and Fink, M. : Changes in Language During Electroshock Therapy, in Psychopathology of Communication, eds. Hoch, P. and Zubin, J., Grune & Stratton, N.Y. 1958, 126-139.

8. Jaffe, J.: An Objective Study of Communication in Psychiatric Interviews, J. Hillside Hosp. 6: 207-215, 1957.

9. Pfeiffer, C.C. et al.: Stimulant Effect of 2 - dimethylaminoethanol - - Possible Precursor of Brain Acetylcholine, Science 126: 610-611, 1957.

10. Pennes, H. and Hoch, P.: Psychotomimetics, Clinical and Theoretical Considerations, Amer. J. Psychiat. 113: 887-892, 1957.

11. Abood, L.G., Ostfield, A.M. and Biel, J.: A New Group of Psychotomimetic Agents, Proc. Soc. Exp. Biol. Med. 97: 483-486, 1958.

12. Fink, M.: Effect of Anti-Cholinergic Agent, Diethazine, on EEG and Behavior: Significance for Theory of Convulsive Therapy, A.M.A. Arch. Neurol. & Psychiat. (in press).

13. Fink, M.: Effect of Anti-Cholinergic Compounds on Post-convulsive EEG and Behavior, EEG. Clin. Neurophysiol. (in press).

REFERENCES

14. Fink, M. and Jaffe, J.: Drug Induced Changes in Interview Patterns: Linguistic and Neurophysiologic Indices, in Conference on Psychodynamic Aspects of Neuroleptic Drugs, ed. J. Sarwer-Foner (in press).

15. Verdeaux, G. and Marty, R.: Action sur L'Electroencephalogramme de Substances Pharmacodynamiques D'interet Clinique, Rev. Neurol. 91: 405-427, 1954.

16. Andermann, K.: Electroencephalographic Evidence of Personality Change Produced by Ataractic Drugs in Mentally Disturbed Patients, M.J. Austral. 2: 1-8, 1957.

17. Bradley, P.B. and Elkes, J.: The Effects of Some Drugs on the Electrical Activity of the Brain, Brain, 80: 77-117, 1957.

18. Garattini, S. and Ghetti, V., eds.: Psychotropic Drugs, Elsevier, Amsterdam, .1957.

19. Jorgensen, R.S. and Wulff, M.H.: The Effect of Orally Administered Chlorpromazine on the Electroencephalogram of Man, EEG. Clin. Neurophysiol. 10: 325-329, 1958.

20. Winfield, D.L. and Aivazian, G.H.: EEG. Changes Associated with Intensive Sparine Therapy, EEG. Clin Neurophysiol. 10: 575, 1958.

21. Wikler, A.: Clinical and Electroencephalographic Studies on the Effects of Mescaline, N-allynormorphine and Morphine in Man, J. Nerv. Ment. Dis. 120: 157-175, 1954.

FIGURES

1. Chlorpromazine, oral (male, age 15).

2. Chlorpromazine, oral (female, age 34).

3. Amobarbital, intravenous (male, age 31).

4. Win-2299, intravenous (female, age 41).

5. Electroconvulsive Therapy (female, age 55).

6. Amobarbital, intravenous (female, age 36).

7. Win-2299, intravenous (female, age 51).

ACKNOWLEDGEMENT

We are grateful for the cooperation of the following laboratories who made supplies of the various psychopharmaceuticals fully available: Ciba Pharmaceutical Prods. (reserpine), Lakeside Laboratories (JB-318, 336), Eli Lilly & Co. (amobarbital), Merck Sharpe & Dohme (benactyzine), Riker Laboratories (Deanol), Roche Laboratories (iproniazid), Sandoz Pharmaceuticals (LSD-25), Schering Corp. (perphenazine), Smith, Kline & French Laboratories (chlorpromazine, diethazine), E.R. Squibb & Sons (triflupromazine), Winthrop Laboratories (Win-2299) and Wyeth Laboratories (promazine, meprobamate).